mal tissues; the most striking clinical feature—the flaccid paralysis—is due to the involvement of the anterior horn cells, but poliomyelitis is not to be considered as a disease affecting the anterior horn cells, or even the anterior gray matter primarily or exclusively, for oftentimes the mesodermal tissues—the pia, blood-vessels, and lymph spaces—are predominantly involved. Neither are the lesions found in the spinal cord alone, for almost every fatal case shows evidences of an extension of the inflammatory process in the brain stem and often, also, to the cerebrum. Many patients have symptoms pointing to involvement of the cranial nerves, and in some the process is essentially bulbar, pontine, or mid-brain, giving pupillary changes, extra-ocular paralysis, ptosis, nystagmus, facial paralysis, or difficult respiration and deglutition. A more accurately descriptive term would, therefore, be acute polio-encephalomyelitis. Whether the polyneuritic-like symptoms are due to a true neuritis or to a posterior root ganglion inflammation or central in origin, is not known. However, the process most commonly involves the lumbosacral region of the cord, and this localization gives the characteristic clinical picture.

The gross changes usually are not very marked, though sometimes conspicuous. There may be noted, macroscopically, hyperemia of the meninges, spinal cord or brain; occasionally there are hemorrhagic and necrotic areas.

Microscopically, the usual picture is an inflammatory process with mononuclear-celled infiltration of the leptomeninges extending into the anterior fissure and along the pial processes and vessels into the cord where there is perivascular infiltration, engorged vessels, glial proliferation, and chromatolysis of the ganglion cells.

ANTERIOR POLIOMYELITIS
THE ORTHOPEDIC PROBLEM

By LEONARD W. ELY, M. D., *San Francisco*

From the time when the diagnosis is made, two problems are presented: to prevent deformity, and to secure the maximum amount of terminal function. The amount of residual paralysis will depend upon the extent of damage to the anterior horns of the spinal cord. We have no means of influencing this, except by keeping the patient absolutely quiet. Massage, electricity, and the various other procedures of physical therapeutics are useless. They may be actually harmful in the early stages.

During the early stages our sole purpose is to prevent deformity. Deformity is the result of gravity and of imbalance of muscle. If all the muscles of a limb be paralyzed we have little to fear it, but with the return of some of them to function, active measures of prevention become necessary. If nothing be done, the active muscles shorten and produce contractures and subluxations.

In the lower extremities the most common deformity is a foot drop, from paralysis of the anterior leg groups. The tendency to deformity is increased by the weight of the bed clothes. To forestall this we apply some form of splint. We have little to fear at this time from contractures of other muscles. The recumbent posture and the bed clothes prevent flexion contractures of the other joints.

As the patient begins to go about, other contractures must be prevented. The treatment at this stage is more active than in the earlier stage. The object is to preserve the full range of motion of the joints in the direction of the paralyzed muscles and to get the greatest possible function by the remaining sound muscles.

After the acute stage of the disease, we get the patient up, and by exercise and training let him learn to educate his remaining muscles to perform their maximum amount of function.

At the end of about a year we shall know about how much permanent paralysis confronts us. In the less extensive cases we may proceed on the same lines. When growth has been attained, the tendency to deformity usually ceases. For cases of medium severity various operative measures have been proposed to stabilize the joints.

Tendon transference is often useful if we know its limitations and understand its technic. It is of little good to perform elaborate operations if the patient cannot use the transferred muscles to move his limbs.

With a paralyzed quadriceps extensor cruris, the patient often learns to super-extend the knee in walking, thus locking it, attaining a fair degree of function. If not, then a stiffening operation is advisable. Operations for stiffening the hip are not usually very satisfactory. For an unstable foot I prefer the Whitman astragalectomy.

Involvement of the trunk muscles may cause a marked rotary-lateral curvature. Its treatment is difficult.

To sum up: In the early stage, rest; in the stage of improvement, prevention of deformity; in the late stage, braces or operation.

TORTICOLLIS

By WILLIAM ARTHUR CLARK, M. D., *Pasadena, Calif.*

Review of the literature.
General discussion of the condition.
The results of operative treatment are very good.
The younger the patient, the better will be the result.
Complete correction and disappearance of facial asymmetry can be expected in children under twelve.
In patients over twenty the change in shape of the cervical vertebra secondary to the long-continued position of deformity may preclude a complete restoration of the normal position.
It is wise to consider carefully before undertaking operation in adults, since there may be obtained only enough correction to accentuate the crooked face, and the patient will consider that he has been made worse instead of better.

DISCUSSION *by R. S. Zumwalt, San Francisco; John C. Wilson, Los Angeles; Lionel D. Prince, San Francisco; Walter C. S. Koebig, Los Angeles.*

THE earliest reference to torticollis which I have found is that of 1641, when Isaac Minnius did an open section of the sterno-mastoid muscle for the relief of this condition. About the same time, Robelais first used the name by which the deformity is known today. Tulpius wrote on the subject in 1650. This, of course, is not very ancient history

in medicine, since it was about 2000 years after Hippocrates and about 1400 years after Galen. Still, it was more than 200 years before anesthetics were used and several years before the first hospital was established in the American Colonies. Minnius was one of those pioneer German surgeons who lived in a time of individual experimenting in surgery, when barbers and surgeons were still undifferentiated.

Not many years later Hendik van Roonhuyze, who is said to have been the first to practice orthopedic surgery, was doing operations for wry-neck and harelip. Dupuytren, the ablest and best French surgeon of his time, was the first to treat wry-neck by subcutaneous section of the sterno-mastoid muscle. This was in 1822. In 1873 Samuel David Gross of Philadelphia did myotomy instead of tenotomy for lengthening.

Torticollis, or wry-neck, may be structural or functional in character. The structural type may be either congenital or acquired, but most of the cases we see are congenital. Under congenital forms we have the muscular which is most common, and skeletal which is rather rare. The muscular form is due to permanent shortening of the muscles passing from the clavicular and scapular region to the temporo-occipital region, the chief of which, in connection with this deformity, is the sterno-mastoid. The other muscles shortened, probably secondary and to lesser degree, are the trapezius and splenius capitis. The skeletal form may be due to (1) occipitalization of the atlas on one side, (2) synostosis of the atlas and axis, (3) malformations, such as wedge-shaped cervical vertebrae.

Acquired torticollis may also be either muscular or skeletal. Muscle contracture may follow injury especially in early life, but such cases are usually not permanent. Deformity of the cervical vertebrae may result from disease such as tuberculosis and a wry-neck result, but except in a very broad sense of the word this is not a torticollis. Spasmodic contracture of the sterno-mastoid sometimes occurs, usually in adults, causing a torticollis which is functional and intermittent. It comes in the class of habit spasms and occurs usually in neurotic people.

This paper deals only with the structural muscle type.

Among the total number of deformities coming under the observation of orthopedic surgeons, torticollis forms a very small percentage. Only 0.49 per cent occurred among 1444 cases in Hoffa's clinic, 2 per cent and 1 per cent according to others. At the Los Angeles General Hospital I found only three cases in the records of the past five years, and only one of these was a typical torticollis. At the Pasadena dispensary there has been one case of muscular and two of skeletal in the past three years. There seems to be no predilection to sex, but there is a slight majority of right-sided over left-sided cases. Rarely the deformity is bilateral, in which case the shoulders are high, the neck short, and the chin and face point upward somewhat.

The cause of the contracture is not known. Intrauterine pressure, trauma, ischemia, and infection furnish the basis for various theories. The intrauterine pressure idea seems most tenable because it is well known that a muscle adapts its length to the distance between its origin and insertion. If this distance is decreased the muscle shortens itself proportionately. I have recently had an experience which supports this theory. A girl 4 years of age was brought for treatment of a high, right dorsal scoliosis, with right shoulder higher than the left. Soon after the application of a plaster jacket in an overcorrected position, the right shoulder low and the left high, it was noticed that a right torticollis was developing. This gradually increased until the deformity was quite marked, the head in the typical position tilted to her right and rotated to her left. When the patient was put in a permanent leather corset, however, with the shoulders level, the torticollis slowly diminished, and at the present writing, about three months since its appearance, it is scarcely noticeable. The explanation of this seems to be that the right sterno-mastoid and other muscles on the right of the neck were originally shorter than those on the left, due to the higher right shoulder, and when the position of the shoulders was reversed a tension was put on the right side which pulled the head over. If the head of the fetus is held to one side against the shoulder, by pressure of the uterus, it would seem that the muscles on that side would be shorter than those of the opposite side, and when the pressure was released the tension would produce the characteristic deformity. Siffel studied six cases of congenital torticollis in an obstetrical clinic when it was customary to use roentgen ray for diagnosis of position in pregnancy. Four of these had been rayed in utero at five to six months, and an inclination of the head was noticed in all of them. He states that this inclination is more common in breach and transverse positions, and concludes that the subsequent torticollis is due to muscle-shortening, either from arrested development or from inclination of the head in the uterus. Schubert, however, regards the intra-uterine theory as untenable, because the deformity is sometimes associated with other malformations, usually hemilateral, and because of the frequent instances of heredity. He places the origin in a primary disturbance of the central nervous system. Roger and Pourtal found anomalies of the cervical vertebrae in seven out of eight cases, but thinks that these may be secondary and that the true source of the trouble may be in the brain.

The ischemia theory is supported by Meyerding, whose paper is based on a study of twenty-six cases. He regards the condition as a chronic interstitial myositis resulting in ischemia, caused by interference with the blood supply from pressure. This, of course, is analogous to Volkmann's contracture. Eight of his cases gave a history of trauma at birth, which may have resulted in hematoma of the sternomastoid and consequent pressure. Other adherents to this theory are Volker, Kempf, Ritter, and Schloesmann.

Mikulicz assumes an infectious origin; a chronic inflammatory process resulting in a myositis. Stromeyer's trauma theory has very little support.

The microscopic pathology of the muscle has been studied by Bouvier, Krogius, Volkmann, Mikulicz, and others sufficiently to establish the character of the muscle change. There is a substitution of fibrous connective tissue for muscle, sometimes almost total

replacement, producing a fibrous band. The muscle fibers which are left have lost their cross-striations.

Symptoms are almost all objective. There is usually no pain or discomfort. The objective signs in the typical case are inclination of the head toward the side of the contracted muscle, and rotation of the face and chin toward the opposite side. This is purely a mechanical result of the muscle pull. The skull as a whole acts as a lever in its antero-posterior line, the fulcrum being at the articulation with the atlas, the power end at the occiput, and weight end in front. The sterno-mastoid insertion is on an elongated area beginning at the mastoid process and extending posteriorly, about one-fourth being on the occipital bone. The pull of this contracted muscle, then, is practically all posterior to the atlas articulation, which, of course, throws the other end of the lever (the face) in the opposite direction.

The facial asymmetry, which is present in most cases of long standing, is explained by retarded development of the skull on the contracted side, probably as a result of relatively poor blood supply. The eye is lower and the entire vertical length of the face is shortened on the affected side. Close observation will show that there is a broad vertical curve in the face, the concavity on the affected side. It has been shown in some cases that on the affected side the carotid artery is actually smaller than on the other side. Other theories which seek to explain the facial asymmetry are atrophy of disuse and irregularity in fusion of ossification centers in the skull. This asymmetry tends to disappear after the torticollis is corrected if the patient is not too old. Immediately after correction, however, it is more noticeable because it looms up in contrast to the new straight position of the head. The patient and parents should be warned of this beforehand.

Diagnosis of muscular torticollis is not difficult with an obvious contracture which is easily seen and felt. Occasionally one sees a case in which no contracture is present, and then attention should be turned to the cervical spine. It should be carefully studied by roentgenogram, as well as clinically, for evidence of anomaly or disease. A tubercular spine would, of course, be limited in motion in all directions by muscle spasm. In such a case the chin points to the same side as the inclination of the head. The same is true for any other form of arthritis in the neck. If the spine is found normal the cervical lymph nodes should be examined for inflammation, the eyes for defects in vision, the ears for suppuration, the teeth for abscesses, and the general musculature for evidence of paralysis.

In a well-developed contracture of the sterno-mastoid the only effective method of treatment is to relieve the contracture by cutting. The only question is where to cut—at the mastoid insertion, in the middle of the muscle, or at the tendinous clavicular end. Incision at mastoid, as done by Mikulicz, has the advantage of a concealed scar, but the disadvantages outweigh this. The insertion is rather extensive, and it is easy to miss some of the muscle fibers which may later cause a recurrence of the deformity. There is danger of injuring the spinal accessory nerve in this region. Myotomy in the middle of the muscle and lengthening by Z-shaped incision is done by some surgeons, but here also the amount of tissue to be cut is large and hemorrhage is extensive. The internal jugular vein is more in danger here than elsewhere. Tenotomy near the clavicle is the method employed by most surgeons. Open incision about 3 cm. in length along the upper border of the clavicle, beginning at the proximal end and extending outward. The tendon is carefully separated from the underlying veins and cut on a dissector, which is passed under it. As soon as the tendon is cut, the head should be twisted into an overcorrected position. This immediately brings out any uncut fibers of the tendon or any other contracted tissues which can then be severed. Delrez cuts, not only the sternal and clavicular tendons, but the fascia clear back to the border of the trapezius. He does not immobilize, but allows free movement so that the deformity can correct itself. In severe cases it is advisable to resect one or two centimeters of the tendon and muscle, as insurance against recurrence. Schubert reports a case in which it was necessary to resect the entire muscle and the spinal accessory nerve to obtain a good result.

After operation the patient is more comfortable, and a better result is insured if the head is immediately immobilized in an overcorrected position. This may be done by applying a plaster cast while the patient is still under the anesthetic. Some surgeons wait until nausea and vomiting are over to avoid soiling the cast, but others have found that, on account of tenderness, it is difficult to get the patient's co-operation sufficiently to obtain at this time the extreme overcorrection necessary to insure a good result. The cast must come well down on the thorax, to furnish a firm anchorage for the head piece. In a method which I observed in Belgium during the war the cast included the shoulder and upper arm on the side opposite the tenotomy. An objection to this method is that with adduction of the arm the head tends to move back toward the original position of deformity.

In lieu of a cast there are several forms of harness-like appliances which hold the head in the proper position, provided the patient does not loosen the buckles.

Complications during or following the operation may occur. The jugular vein may be opened and serious hemorrhage result. Nerve injury may be caused by stretching of the upper spinal nerve roots while making the overcorrection. Engel reports a case of paralysis of the deltoid, biceps and supination longus, which was noticed on removal of the cast. It seemed to have been due to tension on the fifth and sixth roots, and gradually disappeared.

After immobilization for about four weeks, massage and motion is started. The chief aim of massage and passive motion is to prevent recurrence of the contracture and adhesion of the scar to the bone. Active exercises should include all the muscles around the neck and should begin early, to avoid protracted stiffness. Stimulation of the circulation by baking is a valuable aid in obtaining the softening of the tissues, which is necessary to free motion. If the patient is treated three times a week for a month, and observed once a week for two months thereafter, there will not be much chance for recurrence.

In children under about 3 years of age torticollis may be completely cured by physiotherapy without operation. The same may be said of very mild cases at any age. Treatment should be given daily, consisting of forcible stretching followed by exercises. Some form of retention apparatus may be worn to maintain as much correction as possible between treatments.

Cases on the border line, where it is doubtful whether operation ought to be done or those patients who refuse any cutting, may be given an anesthetic and the tight muscle forcibly but slowly stretched. A cast is then applied, maintaining as much overcorrection as possible. This procedure may be repeated as often as necessary, and is followed up by physiotherapy in the same manner as after open operation.

The results of operative treatment are very good. The younger the patient, the better will be the result. Complete correction and disappearance of facial asymmetry can be expected in children under 12. In patients over 20 the change in shape of the cervical vertebra secondary to the long-continued position of deformity may preclude a complete restoration of the normal position. The asymmetry of the face in such cases may not completely disappear. It is wise to consider carefully before undertaking operation in adults, since there may be obtained only enough correction to accentuate the crooked face and the patient will consider that he has been made worse instead of better.

810 Professional Building.

DISCUSSION

R. S. ZUMWALT, M. D. (960 Guerrero Street, San Francisco)—I have read Dr. Clark's very able paper, and congratulate him upon the thorough way in which he has covered the subject.

I was glad to notice the warning he gives regarding adult patients with facial asymmetry in addition to their torticollis, a very frequent combination.

JOHN C. WILSON, M. D. (1136 West Sixth Street, Los Angeles)—The subject of torticollis has been very thoroughly covered by Doctor Clark.

The question of etiology brings up some interesting discussions. The theory of interstitial myositis being the principal cause seems the most rational. A hemorrhagic myositis has been known to develop into an interstitial myositis with contractions even with massage, and it would seem that trauma during passage through the birth canal, with ensuing hemorrhage and fibrosis, must be regarded as the most probable cause. If such is the case the term "congenital torticollis" becomes a misnomer.

Correction as early as possible is always proper because of the danger of a cervical scoleosis, which is certain to develop during the period of growth if the deformity of the head is not corrected.

Serious accidents have been reported following the immediate application of plaster of paris dressing after operation, probably due to stretching of the vagus nerve. As a rule, the head can be held in position by sand-bags or adhesive plaster for two or three days, and a plaster dressing may then be applied in safety without lessening the correction.

If the condition has been of long duration, structural changes in the cervical spine become the most important factor in the treatment. Exercises, both active and passive, may be necessary for several months.

LIONEL D. PRINCE, M. D. (Flood Building, San Francisco)—Doctor Clark has given us a very excellent paper on torticollis. The etiology of congenital torticollis, in common with other congenital anomalies, has always been a source of controversy. While there is no doubt that the cause and pathology may be definitely determined in certain cases, the origin of cases which are either associated with combined congenital anomalies or where heredity is in evidence has not as yet been explained. The pathology frequently seen, such as lessened contractibility of the involved muscles or a fibrous myositis, except in those cases where there is a history of trauma or infection, may be secondary changes resulting from the anomalous condition.

The facial asymmetry associated with a case of torticollis is purely static and simply another instance of accommodative anatomical changes to abnormal posture. If the one-sided position of the head is corrected during the developmental period the asymmetry will gradually disappear. One occasionally sees this same type of asymmetry in children where the head has been tilted over a period of a number of years, as a result of an acquired condition such as tuberculosis of the cervical spine.

The operation of choice is that best described by Clark, namely, a tenotomy at the lower end of the muscle. Subcutaneous tenotomy is dangerous and should never be employed. In most cases it is necessary to incise both the sternal and clavicular attachments of the muscle.

The maintenance of the overcorrected position in a plaster paris splint, following operation, is extremely essential. The application of the splint two or three days after the operation is preferable in those cases where the type or disposition of the patient will permit it. A precaution which I have found valuable, especially where the cast is to be applied immediately after the operation, is to have in writing, for reference, the desired position of overcorrection of the head.

W. C. S. KOEBIG, M. D. (1052 West Sixth Street, Los Angeles)—Doctor Clark has covered the subject of torticollis in a very thorough manner.

The etiology of torticollis offers a large field for discussion. There is much to be said in support of both those who hold the theory that it is congenital, and those who think that it is acquired. It would be reasonable to suppose, however, that the men who hold the theory that difficult delivery is a result rather than a cause of torticollis, owing to the abnormal relationship of the parts in the birth canal, have much to support them. There can be further injury to the muscles during birth. It would be interesting to note the number of cases of muscular torticollis there are following the Caesarean operation, and compare the percentage with that following delivery in the normal way. If the developmental theory holds true, then the percentage would not be diminished by Caesarean operation.

While the operation of choice is a tenotomy of the lower end of the muscle, in selected cases the operation in which the sternal branch is divided close to its insertion and the clavicular branch as high up as possible, followed by uniting the two cut ends, seems to be ideal. Convalescence is shorter and there is not so much formation of scar tissue.

The early maintenance of the head in overcorrection, held by plaster, is exceedingly dangerous, except in the very young, where the underlying tissues are pliable. The shortened blood-vessels, nerves, and other structures may be injured. Application of the plaster splint in as much correction as possible without using too much force, is preferable. In a day or so the cast can be split and more correction given. This can be followed every alternate day until the full amount of overcorrection is obtained. This method will give uniformly good results if judiciously carried out.

According to a Decision of the Judicial Council, A. M. A.—"By the term 'contract practice,' as applied to medicine, is meant the carrying out of an agreement between a physician or a group of physicians, as principals or agents, and a corporation, organization, or individual, to furnish partial or full medical services to a group or class of individuals for a definite sum or for a fixed rate per capita."

"Let everyone in every department of medical endeavor be forgetful of self, but mindful of the greatness and majesty of their calling, bend every energy toward the welfare of their patients. Let no diagnostic stone remain unturned to ascertain their trouble and no therapeutic measure neglected to insure their recovery."—*F. W. Mann, Ohio Med. Jour., Oct. 1, 1925.*